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Tomographic Site Characterization Using CPT, ERT and GPR

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Abstract

The US Department of Energy (DOE) is responsible for the clean up of inactive DOE sites and for bringing DOE sites and facilities into compliance with Federal, State and local laws and regulations. The DOE's Office of Environmental Management (EM) needs advanced technologies that can make environmental restoration and waste management operations more efficient and less costly. Significant savings, in both time and money, can be realized with better site characterization and monitoring techniques. These techniques are required to better characterize the physical, hydrogeological, and chemical properties of the subsurface while minimizing and optimizing the use of borcholes and monitoring wells. Today the cone penetrometer technique (CPT) is demonstrating the value of a minimally invasive deployment system for site characterization.

CPT uses a variety of sensors for measuring soil properties, such as, pore pressure, resistivity, temperature, pH, and seismic wavespeed. Studies have shown that CPT site investigations at hazardous waste sites are a very cost effective method for accessing the subsurface without drilling. In its continuing effort to support cost-effective environmental restoration, Applied Research Associates is developing two new sensor packages for site characterization and monitoring. The two new CPT methods are:

. Electrical Resistivity Tomography (ERT) and

• Ground Penetrating Radar (GPR) Tomography.

Surface ERT and GPR have proven to be useful techniques for imaging subsurface structures and processes; however, depth of investigation is limited. Borehole use of ERT and GPR require the installation of system components via drilled boreholes. The purpose of this new program is to make possible the installation of ERT and GPR units by cone penetrometer and thereby reduce installation costs and total costs for ERT and GPR surveys. Using the cone penetrometer for environmental site characterization represents a new application of the technology. Significant advantages of the CPT include: eliminating drilling wastes and the need for treatment and disposal of drill spoils as hazardous material; reducing the possibility of cross contamination (by grouting the hole as the probe is withdrawn), and is faster than conventional drilling and sampling

Applications and Benefits

This program address a range of DOE applications which fall into two categories: site characterization and monitoring. Technologies used for site characterization and monitoring have numerous and diverse applications within site clean-up and waste management operations. DOE has identified a need for sensors, sensor deployment means, and sensor data processing, including sensor data fusion methodologies for:

. detection and monitoring of contaminates in soils, groundwater, and process effluents;

. expediting site characterization; and

. geological and hydrogeological characterization and monitoring of the subsurface environment.

Our program specifically addresses each of these needs:

1. Sensors: Electrical Resistivity Tomography and Ground Penetrating Radar Tomography
2. Sensor Deployment: Cone Penetrometer Techniques
3. Sensor Data Processing: Tomographic Imaging
4. Sensor Data Fusion: ERT and GPR

Specific benefits are numerous where cost effective underground imaging is very important:

1. Delineating the continuity of soil layers between penetrometer holes;
2. Locating and mapping sand and clay lenses between penetrometer holes;
3. Mapping DNAPL plumes;
4. Defining spatial and temporal behavior of a steam flood for dynamic stripping;
5. Detecting leaks under tanks at Hanford, WA;
6. Monitoring the efficiency of air sparging;
7. Monitoring an ohmic heating thermal front;
8. Characterization of burial trenches and pits, including boundaries and contents; and
9. *In situ* measurement of physical properties, i. e., porosity, density and moisture content.

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